Measure in quantum mechanics via interpretations

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Although at the experimental level, measures in quantum mechanics have reached an exceptional precision, we still run up at the theoretical level against inconsistencies between postulates and the macroscopic world. For instance, the wave function is causal and deterministic, and represents all the information, whereas the measure's result is statistical. While the wave function's evolution is linear and unitary, how can quantum superimpositions disappear at the macroscopic level?

The objective of the conference is to show that there exist interpretations of quantum mechanics, which enable to solve these problems, and also to make quantum mechanics more comprehensive.

We will start from the fact that a measure in quantum mechanics eventually corresponds to the measure of the impact of a particle on a detector: i.e. to a position. This position is considered as a hidden variable, while it is indeed the only variable measured directly!

In a second part, we will show that exist two interpretations of quantum mechanics, which consider that the wave function does not represent all the information, and that the position of the mass center must be added in. This is done by the interpretation of de Broglie-Bohm and by the double scale theory, which form a first step towards formalizing the theory of the double solution of Louis de Broglie.

In a second part, we will show that there exist two types of measure depending on the measured variables: for classical variables, like mass, position, electrical charge or momentum, the measure's result is indeed the value of the variable in question. As to the spin variable, the measure of Stern and Gerlach does not represent the value of spin (which is continuous), but the *redressement* (and not the projection) of the spin vector along the axis chosen for the "measure" (which is discrete).

Numerical simulations of experiments (Young's double slit, Stern and Gerlach, EPR-B) will illustrate these results. We will show that the main other interpretations are very well and very simply explained within the double scale approach.

References

L. de Broglie, J. Andrade e Silva, *La réinterprétation de la mécanique ondulatoire*, Gauthier-Villars, 1971.

M. Gondran, A. Gondran, C. Noûs, *The two-scale interpretation: de broglie and schrödinger's external and internal wave functions*, Annales de la Fondation Louis de Broglie 46 (1) (2021) 87–126.

M. Gondran, A. Gondran, *Replacing the Singlet Spinor of the EPR-B Experiment in the Configuration Space with Two Single-Particle Spinors in Physical Space*, Foundations of Physics 46 (9) (2016) 1109–1126, arXiv:1504.04227.

F. Laloé, *Comprenons-nous vraiment la mécanique quantique ?* CNRS Editions